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ABSTRACT

Instructors at two-year community colleges are faced with the challenge of helping students learn content knowledge and skills in an abbreviated period of time. In particular, developing students' critical thinking skills is an essential task. This paper reports on a study in which students in a Human Anatomy and Physiology class at a community college were taught to apply a technique that required them to generate questions in order to develop more complex modes of thinking. Results indicate no significant improvement in the treatment group. (Contains 39 references.) (WRM)

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Teaching Strategies Designed to Assist Community College Science Students' Critical Thinking

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TEACHING STRATEGIES DESIGNED TO ASSIST COMMUNITY COLLEGE SCIENCE STUDENTS' CRITICAL THINKING

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A need to increase career opportunities has resulted in an increase in the demand for higher education and has brought a flood of students to community colleges. Preference for community colleges has been prompted by the economy, flexibility, and open access policies of these institutions. Although the practice of open enrollment is conducive to increasing the numbers of ìat-riskî students in community colleges, the expectation of many of the students is to achieve success in a career following minimal preparation, or to transfer to a senior institution to pursue a higher degree. The challenge for instructors is to help students learn both content knowledge and the skills needed to utilize the knowledge in pursuit of their goals in the abbreviated period of time the students spend enrolled in the two year institution.

Problem

The expectations set forth for professional programs impact preprofessional educational programs. For example, many of the students enrolled in Human Anatomy and Physiology courses at community colleges are pursuing a career in an Allied Health field, with the exception of a few individuals who are taking the course as a prerequisite for work in Sociology or Social Work. Once they have completed their preliminary course work at the community college, application will be made to professional schools for degree completion. As they enter into institutions of higher education, it is expected that students will arrive not only with basic content knowledge, but also with critical thinking skills that are appropriate for their career choices.

While methods for teaching and assessment have long been directed toward mastery of content knowledge, determination of effective ways to increase students' critical thinking skills has not been ìritualizedî into a simple task. Ideally, one might suggest that it would be beneficial

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to introduce general pre-requisite courses that are non-subject specific and are focused on critical thinking. Since many community college students are economically driven to complete academic requirements, however, they cannot necessarily afford to spend additional time taking preparatory courses that are not absolute requirements for their major. Whether thinking skills can be taught in the course of one semester so that students incorporate them into their own learning strategies for application in their study and career is seen as an important question (Weinstein, 1994). We are cautioned, however, that the relationship between critical thinking and success in college is complex and multi-faceted. More research is required in order to investigate other factors such as maturation, drop out rates of less capable students, and motivation that may have a bearing on student success (Spaulding & Kleiner, 1992).

Teaching learning skills or strategies cannot substitute for teaching domain-specific content, since one factor frequently relies on the other (Weinstein & Mayer, 1986). The strategies are taught in order to be used during learning. They consist of behaviors as well as thoughts that are expected to influence the manner in which all information is encoded or processed by a learner. However, if the academic community embeds approaches to thinking within the instruction of content, we may be able to teach the approaches implicitly to students (Marzano, 1992). Resnick (1987) has found that this can be done by asking students to perform tasks that model specific types of thinking processes. Studies by Brown, Bransford, Ferrara, and Campione (as cited in Wittrock, 1986) suggested that when students become aware of the cognitive processes they are using, they are able to transfer them more readily to other areas of their learning.

Exploring ways to improve students' ability to think critically is in step with the current reform movement in education. Directing the attention of students to deliberate questioning activities may result in forcing them to confront misconceptions with which they have grown comfortable so that in resolving their discrepancies, more meaningful learning may result. Questioning the "fit" between the world outside and inside their own minds could contribute to resolving a problem Yager discussed in science education, which is the fact that students do not see the relationship between science and their daily lives or potential careers (Yager & Lutz,

1994). In addition to individual processing, Driver, Asoko, Leach, Mortimer, and Scott (1994) stress the value of discourse in learning about science concepts. As a learner meets new experiences and tries to make them meaningful, construction or reconstruction of ideas becomes important. And, because learning science is sometimes viewed as equivalent to embracing a new culture (Driver, et al., 1994; Aikenhead, 1996), encouraging students to critically view the concepts through social interaction may serve to make the transition into the culture easier, more personally rewarding, and durable.

While critical thinking can make one a more capable consumer, worker, manager, or citizen, Halpern (1989) also comments on the need to be able to deal effectively with the volume of information that electronic technology can place so quickly within one's reach. Additionally, Davis (1993) discusses the ability of a critical thinker to enjoy a more satisfying and interesting life and contribute to the maintenance of a democratic society. This aspect of liberation is recognized by King (1994) who states that the ability to think critically enables individuals to be empowered in order to stay in control of their own lives. Achieving control is most critical in students who may be academically or socially disadvantaged and who are considered to be at risk as they enter postsecondary educational institutions (Wehlage & Ruter, 1986).

A review of 27 studies that were completed from 1950 through 1985 and investigated the effect of instruction directed toward critical thinking showed that specific instruction failed to enhance critical thinking (McMillan, 1987). However, it was the opinion of the reviewer that this may have been due to a lack of clarity in defining what was being measured, the use of inappropriate assessment instruments, and a lack of precision in describing the measures that were to be applied. It was suggested that there was a need to develop assessment materials that would follow the changing lead of cognitive research. The direction indicated was toward descriptions of critical thinking with emphasis on everyday problems, the use of metacognitive skills, and the development of thinking skills in the domain of specific content (McMillan, 1987).

Many of these research directions have been pursued in the classroom. For example, Novak

and Dettloff (1989) found that they were able to help students learn "task analysis." This was accomplished by modeling study guides for Biology students and successfully encouraging the students to independently develop their own guides. Other studies with nursing students preparing for clinical work indicated that skills applied to nursing-related content were very effective in developing critical thinking processes (Girot, 1994). And, in a study by Hanley (1995), students in a critical thinking course who were purposely directed toward a metacognitive analysis of their individual approach to solving a problem showed a significant gain in thinking skills and personal satisfaction. There is increasing evidence, therefore, that research on methods to improve critical thinking is being directed more effectively toward cognitive processes occurring within the learner and between the learner and the learning environment.

With this in mind, it is important to look at students attending community colleges who may require more intense instructional support. Increased enrollments have prompted several studies that focus on identifying students in community colleges who are potentially at-risk with regard to their being able to successfully negotiate the demands of a college level curriculum. Some characteristics that were identified for students potentially at risk were: being out of school five or more years; fulfilling five or more social roles that are conflicting; returning to school due to unemployment; and not having English as the primary spoken language (Tyler, 1993). Other studies found that additional factors affecting students' success were increased age, the need to work full-time and attend college on a part-time basis, and participation in college preparatory or remedial classes during the first semester of enrollment (Windham, 1995).

In research done on first generation college students, it was found that their parents' educational level and the degree of familial support significantly influenced their expectations and college choices (Stage & Hosler, 1989). Many students have also experienced confusion or isolation resulting from their academic as well as cultural and social backgrounds. Due to deficiencies in integration at academic and social levels (Billson & Terry, 1982), the students appear to have lacked persistence and failed to attain degrees. In further research, Terenzini

identified other familial characteristics of at-risk students (Terenzini, Springer, Yaeger, Pascarella, & Nora, 1996). A study was conducted which included 2685 students, of whom 825 were first-generation, and 1,860 were more traditional students attending 23 different institutions. Twenty-three of these schools were four-year universities and five were community colleges. The focus of the study was to ascertain differences between the two groups of students with regard to their precollege characteristics, first year experiences, and any effects these factors would have on cognitive development. The first-generation students were typically found to have a lower income, minority designation, weaker cognitive skills, lower aspirations, less involvement with students and teachers, a greater number of dependent children, and a lack of parental encouragement with regard to their decision to attend college.

With regard to effective instruction of at-risk students, some suggestions have arisen from successful research with students of various age groups. Earlier efforts discussed by Levine (1988) that have produced some degree of success are individual enrichment programs, metacognitive approaches, techniques such as concept mapping and advanced organizers, and computer aided instruction. Other techniques that have been utilized are supplementary reading, brainstorming, and writing assignments (Franse, 1991). Tom Drummond (1998) has compiled some of the best overall practices that may be used in college teaching. Included are methods dealing with delivery of lecture material, cooperative group learning, and helping students develop self-responsibility.

Research by Brophy (1986) indicates that better explanations on the part of teachers would be helpful, while engagement in cooperative learning has been suggested as an effective strategy to enhance learning as this allows interaction with students and teachers and increases opportunities for academic integration (Tyler, 1993). Cooperative learning in a college level computer lab course, for example, increased both the performance and retention of students engaged in cooperative learning versus those students receiving traditional instruction (Keeler & Anson, 1995).

Finding appropriate ways to teach students critical skills is challenging. Curriculum must be

kept simple, friendly and understandable. Students come with complex house plans and want to be able to run power tools so that they can quickly build their ìdream homeî and be finished with the educational experience. However, educators are also interested in helping them learn the art of fine craftsmanship. We study the quality of the ìwoodî to be used, try to cut it into the best shape for the purpose under consideration, and use ìsandpaperî techniques to remove the rough edges so that it will be sound fitting as well as comfortable. Skills acquired by students should be long lasting and durable for a pleasant and productive future.

The purpose of the study was to determine whether learning thinking strategies within the context of a community college course would result in studentsí increased academic performance and incidence of critical thinking skills. If successful, benefits gained by students would not be limited to science instruction, but may provide a relatively trouble-free way to increase their ability to think critically within the context of any subject area, or well beyond that context.

Method

Students in a Human Anatomy and Physiology class were taught to apply a technique that required them to generate questions (Arburn, 1998). The technique used a set of generic question stems employed by students as a format to fill in with specific content covered in the lecture class. The question stems had been identified as to the level of cognition each demonstrated. Students who had been taught to use the question stems have demonstrated significant improvement in their learning (King, 1990, 1991, 1994). While the technique had been used successfully at senior institutions, it had not been employed at the community college level of instruction.

The technique was introduced during a regular class meeting where participants were told of the success effected by use of the technique to learn more complex methods of thinking. Following distribution of a reference sheet containing the question stems, sample questions were generated with the help of the instructor. The question stems were intended to work as scaffolds in that they supported students as they learned to ask questions and also reduced the complexity

of the technique as it was being learned. However, the question stems did not specify each step a student needed to complete for the purpose of actually generating a question. The choice of the stem and its completion were left to the student (Schrag, 1992).

The questioning technique was used for a period of eight weeks. The time period of treatment was based on early studies using guided questions in which six successive lectures within a three month semester produced significant results with regard to improvement in students' achievement (King, 1989). Following lecture presentation of new material, students were required to use the question stems to write a question based on the material that had been presented. The questions were then exchanged with a peer who was given a few more minutes to provide a written answer to the question. Emphasis was not directed toward grammatical accuracy or factual correctness of the response. The use of student-generated questioning techniques has resulted in improved lecture comprehension on the part of university students (King, 1989). In fact, in the studies by King, these techniques proved more effective than independent review and peer questioning in small cooperative groups. These and additional studies were included in a review of 26 studies in which students were taught to generate questions. A comparative analysis of all methods employed in the studies showed that signal words and generic questions or question stems resulted in the greatest improvement in comprehension (Rosenshine, Meister, & Chapman 1996).

Students were pretested at the beginning of the semester using the Learning and Study Strategies Inventory (LASSI) and California Critical Thinking Skills Test (CCTST) to profile their personal learning strategies and ability to engage in critical thinking. At the end of the semester, posttesting was carried out using the same instruments. Students in a control group were similarly tested but did not engage in the use of question stems. The final course content examination scores of all students were also analyzed, using their entry Grade Point Average as a covariate.

The LASSI includes individual scales that measure attitude, motivation, time management, anxiety, concentration, information processing, selecting main ideas, study aids, self testing, and

test strategies. Of these items, information processing has been suggested to be an indicator of critical thinking (Weinstein, 1987). The CCTST also includes individual scores that can be used to show changes in inductive reasoning, deductive reasoning, analysis, inference, and evaluation (Facione, 1992).

Results

In the current study, application of student-generated question stems following lecture did not result in improving the achievement scores of students as significant results were not found when comparing the control and treatment groups. It should be noted that the same exam was administered to all group. And, the application of Cronbachís Alpha showed that the internal consistency of the exam had a value of 0.89.

Characteristics of length of intervention, mode of application, and evaluative methods that were used fit the general profile of previous studies using the question stems. What differed, however, were the population of students and the nature of the content material. It is possible that an interface between students who may not be academically prepared and content material that is technically complex and challenging may be a chasm that requires a longer period of intervention in order to be effectively traversed. Further manipulation of the length or type of intervention may provide viable options to assist in clarifying the issue.

In light of the results obtained, however, it would be constructive to illustrate a benefit elucidated as a result of the study. What can be concluded is that the use of the questioning technique did not serve to diminish the performance of students on the final examination. This should provide encouragement to many teachers in content intensive disciplines who are hesitant to relinquish the podium to methods of instruction that are less didactic in nature. Frequently, there is a concern that material will not be thoroughly or appropriately addressed during the course of the class if it is not addressed by way of a lecture. To cling to this attitude may not only prove fallacious but may deprive students of an opportunity to gain higher cognitive skills that are needed in order to appropriately assimilate and apply the content that has been addressed.

In seeking an explanation for these results, it is also relevant to consider the nature of the material being learned and the disposition of the learner. At-risk students with an academic and social background that may be limited in a new arena are confronting a subject area replete with new vocabulary and extensive, interrelated concepts. Their mastery of appropriate reading and writing skills is sometimes deficient, and some are further challenged by the need to both think and express themselves in a second language. Under these circumstances, relating new material to that which is already known may not present itself as a feasible, urgent, or prime strategy choice. The immediate demand for simply organizing and consuming a massive amount of new material may have a tendency to overshadow or supersede the need for more appropriate assimilation of the material. If this is the case, the instructor must more actively assume the responsibility of assisting students in this task by providing opportunities to help them relate the subject matter to their own, though possibly limited, realm of experience. A study by Collins and Smith (as cited in Wong, 1985) has shown that a lack of prior knowledge may make it difficult to understand information that has been presented. However, unsuccessful activation of prior knowledge may be an even more important problem to examine and seek to change (Bransford, Stein, Vye, Franks, Auble, Mezynski, & Perfetto, 1982).

Analysis of performance on LASSI showed no significant change in the use of an information processing strategy by students in the study. However, further analysis of other scales measured by LASSI showed a significant change in the studentsí ability to select main ideas. Learning to select main ideas may be result from the necessity for seeking ways to effectively master new material. As students progress through a course that is very content intensive, this would be an important strategy to learn. And, having to generate questions based on the material appears to have contributed to the development of this strategy in the experimental group of students. Improving one's ability to focus on material that is more important maximizes the efficiency of studying efforts (Weinstein, 1987). Development of the strategy could, therefore, have been enhanced by the use of the questioning technique due to the fact that students had to identify important points within the lecture material on which to base

their questions.

While overall CCTST scores were not significantly changed by the intervention, examination of the respective indices showed that the use of question stems did significantly increase the studentsí use of deductive reasoning and inference. Typically, deduction connotes the ability to reach a conclusion by reasoning from a general premise to a more specific conclusion. While syllogisms or mathematical proofs provide examples of deduction (Facione, 1990), its usefulness is not limited to these applications. In fact, one could look at another clinical example to illustrate deduction. If your patient had diabetes, what complications might be anticipated? It is not unreasonable to expect circulatory complications that could become manifest as problems with vision, the kidneys, or ulceration on the feet and legs that could even become gangrenous if left untreated.

Application

In summary, the absence of improvement in achievement failed to confirm results of earlier studies where intervention based on generating questions was successful (King, 1989; Redfield & Rousseau, 1981; Rosenshine, Meister, & Chapman, 1996; Wong, 1985). And, significant improvement was not effected in information processing or an overall measure of critical thinking. Positive results were obtained, however, in the ability of students to select main ideas and engage in inference and deductive reasoning. The long-term effects of this improvement remain to be investigated.

While community college teachers have been recognized for their interest in students and the improvement of pedagogy, their ability to effectively reach and teach non-traditional and at-risk students promises to remain a challenge. The present study and the success that it demonstrates is offered as a valuable addition to a repertoire of easily applied, reliable, and productive techniques for the nature of cognitive activities in the classroom. Instructors can expect benefits if they will make a commitment to relinquish time from the podium in order to introduce students to the purpose and method of the technique to be used, allow time for its practice, and celebrate in the expectation that students may derive benefit from its use.

References

Aikenhead, G. S. (1996). Science education: Border crossing into the subculture of science. *Studies in Science Education, 27*, 1-52.

Arburn, T.M. (1998). Assisting at-risk community college studentsí acquisition of critical thinking learning strategies in human anatomy and physiology. *Dissertation Abstracts International, 59* (06), 164A. (University Microfilms No. AAT98-37897)

Billson, J. M., & Terry, B.T. (1982). In search of the silken purse: Factors in attrition among first-generation students. *College and University, 58* (1), 57-75.

Bransford, J. D., Stein, B. S., Vye, N. J., Franks, J. J., Auble, P. M., Mezynski, K. J., & Perfetto, G. A. (1982). Differences in approaches to learning: An overview. *Journal of Experimental Psychology: General, 111*, 390-398.

Brophy, J. (1986). Teacher influences on student achievement. *American Psychologist, 41*, 1069-1077.

Davis, J. R. (1993). *Better teaching, more learning: Strategies for success in postsecondary settings*. Phoenix, AZ: Oryx Press.

Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher, 23* (7), 5-12.

Drummond, T. (1995). A brief summary of the best practices in college teaching. Retrieved April 12, 1998, from the World Wide Web:
http://www.nsccux.sccd.ctc.edu/~eceprog/bstprac.html

Facione, P. A. (1990). Critical thinking: a statement of expert consensus for purposes of educational assessment and instruction. *Executive Summary: The Delphi Report*. Millbrae, CA: The California Academic Press. (ERIC Document Reproduction Service No. ED 315 423)

Facione, P.A. (1991). The California Critical Thinking Skills Test: (CCTST), Form A (1990) and Form B (1992). Millbrae, CA: California Academic Press.

Franse, S. R. (1991-1992). Successful instructional strategies for the community college

student. *Community Review*, *12* (1-2), 33-35.

Girot, E. A. (1994). Preparing the practitioner for advanced academic study: The development of critical thinking. *Journal of Advanced Nursing*, *21*, 387-394.

Halpern, D. F. (1989). *Thought and knowledge: An introduction to critical thinking*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Hanley, G. L. (1995). Teaching critical thinking: Focusing on metacognitive skills and problem solving. *Teaching of Psychology*, *22* (1), 68-72.

Keeler, C. M., & Anson, R. (1995). An assessment of cooperative learning used for basic computer skills instruction in the college classroom. *Journal of Educational Computing Research*, *12*, 379-393.

King, A. (1989). Effects of self-questioning training on college students' comprehension of lectures. *Contemporary Educational Psychology*, *14*, 1-16.

King, A. (1990). Enhancing peer interaction and learning in the classroom through reciprocal questioning. *American Educational Research Journal*, *27*, 664-687.

King, A. (1991). Improving lecture comprehension: Effects of a metacognitive strategy. *Applied Cognitive Psychology*, *5*, 331-346.

King, A. (1994). Autonomy and question asking: The role of personal control in guided student generated questioning. *Learning and Individual Differences*, *6*, 163-185.

Levine, D. U. (1988). Teaching thinking to at-risk students: Generalizations and speculation. In B. Z. Presseisen (Ed.), *At-risk students and thinking: Perspectives from research* (pp. 117-137). Washington, DC.: National Education Association of the United States.

Marzano, R. J. (1992). A rationale and framework for teaching thinking tactics. In J. W. Keefe & H J. Walbert (Eds.), *Teaching for thinking* (pp. 15-25). Reston, VA: National Association of Secondary Principals.

McMillan, J. H. (1987). Enhancing college students' critical thinking: A review of studies. *Research in Higher Education*, *26* (1), 3-29.

Novak, J. A., & Dettloff, J. M. (1989). Developing critical thinking skills in community college students. *Journal of College Science Teaching, XIX* (1), 22-25.

Redfield, D. L., & Rousseau, E. W. (1981). A meta-analysis of experimental research on teacher questioning behavior. *Review of Educational Research, 51*, 237-245.

Resnick, L. B. (1987). *Education and learning to think*. Washington, DC.: National Academy.

Rosenshine, B., Meister, C., & Chapman, S. (1996). Teaching students to generate questions: A review of the intervention studies. *Review of Educational Research, 66*, 181-221.

Schrag, F. (1992). Nurturing thoughtfulness. In J. W. Keefe & H. J. Walbert (Eds.), *Teaching for thinking* (pp. 27-34). Reston, VA: National Association of Secondary Principals.

Spaulding, S. C. & Kleiner, K. A. (1992). The relationship of college and critical thinking: Are critical thinkers attracted or created by college disciplines? *College Student Journal, 26*, 162-165.

Stage, F. K., and Hossler, D. (1989). Differences in family influences on college attendance plans for male and female ninth graders. *Research in Higher Education, 30*, 302-305.

Terenzini, P. T., Springer, L., Yaeger, P. M., Pascarella, E. T., & Nora, A. (1996). First-generation college students: Characteristics, experiences, and cognitive development. *Research in Higher Education, 37* (2), 1-22.

Tyler, D. A. (1993, May). At risk non-traditional community college students. Paper presented at the annual international conference of the National Institute for Staff and Organizational Development on Teaching Excellence and Conference of Administrators, Austin, TX. (ERIC Document Reproduction Service No. ED 361 055)

Wehlage, G. G., and Ruter, R.A. (1986). Dropping out: How much do schools contribute to the problem? *Teachers College Record, 87*, 37-58.

Weinstein, C. E. (1987). *LASSI user's manual*. Clearwater, FL: H & H Publishing Company, Inc.

Weinstein, C. E. (1994). Strategic learning/strategic teaching: Flip sides of a coin. In P. R. Pintrich, D. R. Brown, & C. E. Weinstein (Eds.), *Student motivation, cognition, and learning* (pp. 257-273). New Jersey: Lawrence Erlbaum Associates.

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In M. C. Wittrock (Ed.). *Handbook of research on teaching* (pp. 315-327). New York: Macmillan.

Windham, P. (1995, August). *The importance of work and other factors to attrition: A comparison of significance and odds ratios for different outcomes.* Paper presented at the annual conference of the Southeastern Association for Community College Research, Asheville, NC. (ERIC Document Reproduction Service No. ED 385 312)

Wittrock, M.C. (1986). Studentsí thought processes. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 297-314), New York: Macmillan Publishing Company.

Wong, B.Y.L. (1985). Self-questioning instructional research: A review. *Review of Educational Research*, 55, 227-268.

Yager, R. E. & Lutz, M. V. (1994). Integrated science: The importance of "how" versus "what". *School Science and Mathematics*, *94*, 338-346.